of Mte. Cantomoro, Penna, and Scaletta extend south-east, towards Varese-Ligure, to Mte. Quatese, Cavallone, Setterano, and Carignone, all at about 1,300 metres altitude, in three more or less parallel zones with intervening strata of argillaceous schist containing abundant lenticular intercalations of diabasic breccia, of which extensive agglomerations also appear on the northern flanks of Mte. Penna. The diabasic zones obviously represent original submarine lava streams flowing in the planes of the plastic sedimentary strata in which the débris became infolded and cemented to breccia.

Conclusion.

The phenomena presented by the ophiolithic and sedimentary groups of Eastern Liguria are substantially the same as those of the Triassic Voltri and the Sestri and Isoverde Eocene groups west of Genoa. Both regions afford striking evidence of intense folding, crushing, contortion, and brecciation which the sedimentary and the ophiolithic rocks of submarine eruptive origin during their contemporaneous uprise and subsequent settling experienced alike. There is no tangible evidence of these groups being transported areas, while everything points to their emergence and location in situ.[1] The effects of repeated earth-movements, including those of a seismic character, are strikingly evidenced by the frequently cataclastic condition of the Ligurian littoral from the coast to the crest of the Apennines, and the compression of the region during its uprise and settlement must have been all the greater considering that it lies in the contracted semicircular curve of the Gulf of Genoa.

III.—On the Classification of the Terebratellidæ.

By J. Allan Thomson, M.A., D.Sc., F.G.S., Director of the Dominion Museum, Wellington, New Zealand.

Introduction.

THE observations presented by Mr. J. Wilfrid Jackson (1916)[2] on my paper on "Brachiopod Morphology", published in this Magazine in 1915, are very welcome as furnishing many important details omitted by Davidson and other writers in the description of species. The error into which I fell as regards the types of folding of *Dallina* and *Dallinella* illustrates the danger of relying on figures when specimens are not available, but it was worth while making such an error when the correction of it brought forward so many useful observations on other points, particularly on the prevalence of

microscopically some of the ophiolithic rocks on the north of the Apennines: "Sopra alcune roccie serpentinose dell'Apennino Bobbiese," Boll. R. Com. geol., 1881, p. 58 et seq.; also D. Zaccagna, Relazione, 1902; ibid., 1903, p. 39.

[1] Further east towards Spezia the Mesozoic and Tertiary sedimentary strata exhibit an abnormal superposition which has always been regarded as an extensive inverted fold, but may be the effect of an overthrust. In the ophiolithic areas of Eastern Liguria, on the other hand, the Eocene sedimentary sequence is normal.

[2] References are given in the list of papers at the end of this article, and are indicated in the text by the author's name and date.

dental plates in the Dallininæ and the relationships of *Mühlfeldtia*. These observations pave the way for a further advance in the natural or genetic grouping of species and genera. At the same time, while admitting that *Dallina* is ventrally biplicate, I am not disposed to agree with Mr. Jackson that the folding is exactly comparable to the ventral biplication exhibited in some species of *Magellania*, but probably arose in a different way. I refrain from a further statement on this point, as I understand that Mr. S. S. Buckman is discussing the subject of types of folding fully in his forthcoming memoir on the Jurassic Brachiopods of Burma. In what follows I shall have again, through lack of specimens in Colonial museums, to rely on figures to some extent, and may possibly again err from this cause, and if so hope the correction will be applied as promptly and informatively as in the former case.

Primary Divisions of the Terebratellidæ.

Beecher, in 1895, recognized three subfamilies within the Terebratellidæ, distinguished by loop characters and development, viz.: the Megathyrinæ, the Dallininæ, and the Magellaninæ. In 1897 Schuchert included besides these three also the Devonian Tropidoleptinæ, but in 1913 he relegated this subfamily to the Strophomenidæ, with the other members of which it agrees more nearly in geological age, and retained in the Terebratellidæ only the three subfamilies adopted by Beecher, whose epoch-making classification has thus stood the test of time for twenty-one years.

Certain minor modifications of Beecher's statement of the order of loop development in the higher subfamilies of the Dallininæ and Magellaninæ have become necessary owing to the re-naming and closer definition of some of the genera on which he based his terms. The following table shows the former and the revised nomenclature:—

Stages of Loop Development in Terebratellids.

Dallininæ.		Magellaninæ.	
Beecher, 1895.	Revised Nomenclature.	Beecher, 1895.	Revised Nomenclature.
Platidiform.	Platidiform.	Bouchardiform Megerliniform	Premagadiniform.
Ismeniform.	Ismeniform.	Magadiform.	Magadiniform.
Mühlfeldtiform.	Frenuliniform.	Magaselliform.	Magelliform.
Terebrataliform.	Terebrataliform.	Terebratelliform.	Terebratelliform.
Dalliniform.	Dalliniform.	Magellaniform.	Magellaniform.

The reasons for an alteration of the terms applied to early stages of *Terebratella* and *Magellania* have been fully explained in former papers (Thomson, 1915, Nos. 2 and 3). The substitution of 'Frenuliniform' for 'Mühlfeldtiform' has been proposed by Jackson (1916) on the ground that *Mühlfeldtia* belongs to the Magellaninæ and not to the Dallininæ. In any case 'Frenuliniform' is the

preferable term, since Beecher had really *Frenulina sanguinolenta*[1] in mind when he spoke of *Mühlfeldtia*, for although he mentioned *M. truncata* he used in his illustrations *M. sanguinea* = *Frenulina sanguinolenta*.

The so-called 'Platidiform' stage of the loop in the Dallininæ is not strictly comparable to the brachidium of *Platidia*, as is shown below, and does not appear to be represented in the adult brachidium of any known genus, but it can hardly be doubted that a genus with such characters will one day be found.

Jackson's reasons for removing *Mühlfeldtia truncata* from the Dallininæ and placing it in the Magellaninæ are the absence of dental plates, the resemblance of one of its early loop stages to an early loop stage of *Terebratella dorsata*, and the appearance of the secondary loop before the appearance of the primary lamellæ. Deslongchamps showed clearly in 1884 that the young loop stages of *Megerlia truncata* (=*Mühlfeldtia truncata*) form a close parallel with the adult brachidia of *Kraussina* and *Megerlina*, and it is somewhat remarkable that Beecher overlooked this resemblance and did not suspect the generic distinctness of "*Mühlfeldtia truncata*" and "*Mühlfeldtia sanguinea*".

Differences between Dalliniform and Magellaniform Ontogeny.

Before discussing whether *Mühlfeldtia* may be admitted into the Magellaninæ, it is desirable to analyse the difference in loop development between that family and the Dallininæ. Beecher pointed out that in the lower genera the median septum is generally low in the Dallininæ and projecting above the loop in the Magellaninæ. In *Bouchardia*, *Magas*, and *Magadina* it almost touches the opposite valve. In the young growth stages of the higher genera this difference between the subfamilies is not so marked, for the early platidiform stages of *Macandrevia* show a high septum. It remains true, however, that a high septum persists longer in the Magellaninæ than in the Dallininæ. There is also a slight difference in the form of the septum, which is more elongate and board-like in the Magellaninæ.

In both subfamilies the secondary part of the loop appears first as a small hood[2] on the septum, with the opening upwards and forwards. In the Magellaninæ this hood is confined to the posterior, slightly lower, end of the septum, but in the Dallininæ it projects further forwards. At this stage there is an important difference, emphasized by Jackson, viz., that in the Dallininæ the primary loop is complete from the crural bases to the septum, whereas in the Magellaninæ it is imperfect. It does not appear to be yet known whether the

[1] *Anomia sanguinea*, Chemnitz, being polynomial, Gmelin's name must be used for this species as Dall has suggested. Beecher's illustrations are based on those of Deslongchamps (1884), who referred to it as *Terebratella sanguinea*. It is, of course, a different species from *Terebratella sanguinea*, Leach, which was known at that date as *Terebratella cruenta*.

[2] The earliest stage of *Terebratella dorsata* described by Fischer and Oehlert (1892), which shows the secondary loop, has a ring on the septum, but I have detected an earlier stage with a hood in *T. rubicunda* (Thomson, 1915, No. 3).

growth of the primary lamellæ in the Dallininæ commences both from the septum and the crura, as is the case in the Magellaninæ, or from the crura only. In the Magellaninæ the completion of the primary lamellæ is attained only after the hood has developed into a ring, and on its completion the Magadiniform stage is reached. In this stage the primary lamellæ and the ends of the ring are separately attached to the septum, and at a considerable vertical distance apart. In *Platidia*, as figured by Fischer & Oehlert (1891), the same is true, but in the earliest known Platidiform stages of *Macandrevia* and *Dallina* the attachment of the primary lamellæ is very oblique, and the anterior part unites with the end of the hood. A similar oblique attachment and union is not attained in *Terebratella* till a later stage, the Magelliform, when the ring has attained a considerable size and is widely open.

Some similarity exists between late Platidiform and Ismeniform stages of *Macandrevia* and *Dallina* on the one hand and early Magelliform stages of *Terebratella* on the other. In all of these the primary lamellæ are complete, and run forward obliquely up the septum to unite with a ring above. The differences are that in the Platidiform and Ismeniform stages the ring is not so large nor so widely open, while its lower ends project forwards into two divergent points, whereas in *Magella* and in Magelliform stages the lower ends are more or less rounded.

The chief difference in later stages is that in the Dallininæ lacunæ open on the lower sides of the ring and so produce a Frenuliniform stage which has no counterpart in the ontogeny of *Terebratella* or *Magellania*.

Mühlfeldtia and its Allies.

Mühlfeldtia truncata differs in its ontogeny from members of Dallininæ in that the secondary part of the loop appears as a ring before the primary lamellæ appear. Furthermore, as in the Magellaninæ the primary lamellæ grow from each end to unite in the middle. There appear, however, to be other features in which differences from the Magellaninæ exist, and some resemblance to Dalliniform ontogeny may be traced. The high board-like septum of the early stages of the Magellaninæ does not appear to exist so far as one may judge from the figures of Deslongchamps (1884) and Fischer & Oehlert (1891). Certainly in *Kraussina* and *Megerlina* the septum is quite low. The ring above the septum in the earliest known stages of *Mühlfeldtia* is different in shape and position from the ring in pre-Magadiniform and Magadiniform stages of *Terebratella*. It lies further forward on the septum, and the lower sides exhibit forward extensions not shown in the early stages of *Terebratella*. At a later stage in *M. truncata*, and in the adult brachidium of *Megerlina Lamarckiana*, small points which represent the anterior beginnings of the primary lamellæ appear, not on the septum, but on the lower outer sides of the ring, if Deslongchamps' figures may be trusted. This difference both from the Dallininæ and the Magellaninæ appears sufficiently fundamental to necessitate the recognition of a subfamily to include *Mühlfeldtia*, *Megerlina*, and *Kraussina*. Before such a step is taken,

however, it is desirable that a further study of the young stages of *Mühlfeldtia* should be made. Had Deslongchamps presented side views of the specimens he figured, all ambiguity would have been avoided.

In its further development *M. truncata* diverges greatly from the Terebratelliform ontogenetic series. Apparently what in the adult loop resembles the jugal band of a *Terebratella* is really the original bottom part of the primitive ring, little modified except in size. The anterior extensions of the ring become greatly enlarged, and with them the primary lamellæ increase in length, although remaining attached to the lower sides of the ring at their point of origin. Neither Davidson, Deslongchamps (1884), nor Fischer & Oehlert (1891) show in their figures any sign of lacunæ such as occur in *Frenulina*, but in a specimen from the Mediterranean in the Dominion Museum, Wellington, they exist as narrow slits separating for some distance the anterior extensions of the primary lamellæ from the anterior extensions of the ring.

There is another genus which by an anterior extension of the secondary part of the loop prevents some resemblance to *Mühlfeldtia*, viz. *Campages*, Hedley (1905), which occurs on the south and east coast of Australia. In the type species, *C. furcifera*, Hedley, there is also a slight development of lateral lacunæ, but these do not appear to be present in the only other known species, *C. jaffaensis* (Blochmann).[1] Through the kindness of Dr. J. C. Verco, of Adelaide, I have been able to examine a small series of the young of the latter species. In these the typical high septum of the Magadiniform and pre-Magadiniform stages of *Terebratella* is seen, and up to the Magadiniform stage there is no marked difference from the young of *Terebratella* except that the ribbon of the ring is broader and extends further forward. The later stages are not well displayed by the series, but it is evident, from the occurrence of a Magadiniform stage with widely separate attachment of the primary lamellæ and of the ring on a high septum, that *Campages* is not a close ally of *Mühlfeldtia* but an undoubted member of the Magellaninæ, with a loop representing a specialized development of the Magelliform stage.

There are two other species that should be considered in this connexion, viz. *Megerlia Willemoesi*, Davidson, and *Terebratella furculifera*, Tate. The former is a recent species obtained by the *Challenger* Expedition off Twofold Bay, New South Wales, and has a loop resembling that of an early Terebratelliform stage of *Terebratella*, except that the reflected part of the loop is attached to the septum by two descending lamellæ, thus enclosing a triangular space. In *T. furculifera*, Tate, an Australian Tertiary fossil, the same kind of connexion with the septum occurs, but the brachidium appears to be rather more advanced, and comparable to a late Terebratelliform stage. These two species occur in the same region and are thus probably related. Their loop characters are quite distinct from those

[1] Originally described by Blochmann (1910) as *Magasella jaffaensis* and ascribed to *Campages* by Hedley in 1911. Hedley also considered *Magellania Joubini*, Blochmann, a species of *Campages*, but this species appears to be correctly placed under *Magellania*.

of *Laqueus* or any other known genus, and justify the erection of a new genus.

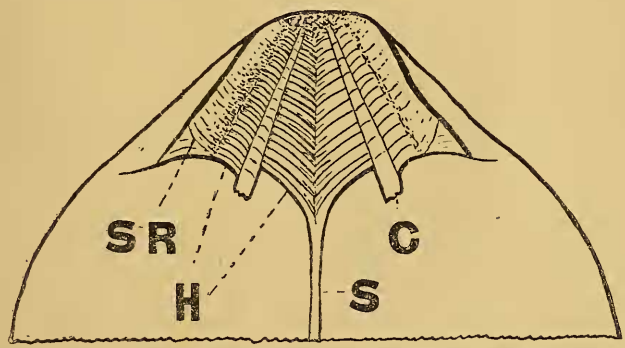
ALDINGIA, gen. nov.[1]

Genotype *Terebratella furculifera*, Tate.

Until the growth stages of *Aldingia* are known, the subfamily of the Terebratellidæ to which it belongs cannot be determined, but it appears not unlikely that it passes through a Mühlfeldtiform stage in its ontogeny, and that the descending lamellæ uniting on the septum are comparable to the sides of the primitive ring in *Mühlfeldtia*.

GENETIC STOCKS IN THE MAGELLANINÆ AND DALLININÆ.

In a former paper (1916, No. 2) I have endeavoured to show that Magellaniform loops have been produced by parallel evolution in at least three distinct stocks, each characterized by its own type of cardinalia[2] and beak characters. There are, doubtless, many other stocks equally worthy of generic recognition in the Magellaninæ, but the evidence for their separate attainment of the Magellaniform loop is not yet forthcoming.



Dallina floridana, Pourtales. Anterior-ventral view of cardinalia of dorsal valve. SR. socket ridge ; H. hinge-plates ; C. crural bases ; S. septum. There is no cardinal process. Enlarged about 2½ nat. size.

Thanks to Jackson's valuable observations we are now able to recognize similar evolutionary stocks in recent Dallininæ. Thus *Terebratalia* and *Thomsonia* are shown both to possess hinge-plates and a similar type of cardinalia differing markedly from that in *Dallina* and *Macandrevia*. As the type of the folding and the beak characters are also similar in *Thomsonia* and *Terebratalia*, these genera doubtless form one evolutionary stock.

Jackson states that *Dallina* possesses typically Magellaniform cardinalia, but it appears useful to draw a distinction. The only

[1] Named from Aldinga, South Australia, a notable locality for Tertiary Brachiopods.

[2] This term I intended as a (Latin) neuter plural, but in my former paper it was used as a singular noun, and I had not an opportunity to revise the proofs.